

- ii) Spectrum privatization can be achieved more easily and efficiently by creating and distributing nationwide rights to a broad spectrum of frequencies (i.e., management rights) rather than by privatizing individual, localized channels (i.e., license rights).

New Zealand's attempt to implement deep reform was caught in the following dilemma. Only the creation and distribution of management rights could provide the basis for full privatization of spectrum management functions. The Ministry of Commerce, however, was prevented from distributing management rights in most cases, due to political pressure from existing licensees, the complexity of the transition, and the small number of commercial organizations capable of taking on broad spectrum-management responsibilities. Hence the government relied almost entirely on auctioning off license rights rather than management rights. (License rights give users the right to specific channels at specific power levels within a band. Management rights give their owners the much broader right to determine how the band will be used, how many users will be licensed, and how interference will be defined.) When license rights are tendered, the government retains a significant amount of the traditional spectrum-management functions. Thus, license rights cannot provide the basis for a full-fledged market for radio frequencies. Overall, reliance on license rights severely diminished the scope of privatization. The factors contributing to the retreat from deep reform are analyzed below.

Incumbent Rights

Any transition to a market regime is faced with the problem of what to do with existing users, those who acquired their rights under the old regime. If the band is being sold off, what is one to do with the people who are already there? It can be argued that existing users have acquired vested rights by virtue of their prior use of the frequencies. Having built up entire businesses dependent upon the use of certain frequencies, existing licensees deserve to be protected or exempted from an auctioning process. The opposing argument is that neither efficiency nor fairness gives existing users any special claims to their licenses. Since every other person will be required to pay for access to spectrum, existing users ought to be required to do so also. Incumbents already have been given the right to free use of the spectrum in previous years. If their ongoing business makes retention of their existing frequencies more valuable to them than to new users, then this value ought to be reflected in their bids.

Although there was disagreement within its ranks, NERA primarily took the latter approach to the incumbency problem. The report recommended that incumbent license holders be given no preference whatsoever in the spectrum tenders. They would be forced to tender for their frequencies along with everyone else. Recognizing the political obstacles such a proposal would engender, NERA set forth as a fallback option that incumbents tender, but be given temporary licenses for three years,

allowing them a transition period if they failed to submit the winning bid. Another alternative was giving incumbents the right to match the winning bid.

In response to vociferous lobbying by broadcasters and Telecom, incumbents were not required to tender for their frequencies. The law was amended to strengthen incumbents' rights. As noted before, the law also exempted nonprofit radio broadcasters from the tendering process.

Thus, the political process created strong pressures to "grandfather" existing spectrum users. Previously granted licenses were vested with property-rights status under the new regime, or incumbents were given an advantage in the bidding process. The strengthening of incumbent rights contributed to the diminution of radical privatization. Bands populated by incumbents or noncommercial licensees exempted from the spectrum tenders could not be turned over fully to private spectrum managers.

License Rights vs. Management Rights

Most frequencies have been tendered as license rights rather than management rights. In this respect, implementation of the law has deviated sharply from the recommendations of the NERA report. This, too, represents a retreat from deep reform.

When confronted with the problem of how to define property rights to the spectrum, the NERA report expressed a preference for management rights—a broad, nationwide band of frequencies with no geographic boundary (other than what is necessary to avoid interference with other countries). Management rights, NERA reasoned, would be more flexible, and would minimize potentially complex and expensive negotiations over interference. Distribution of management rights to private owners was intended to lead to the emergence of spectrum intermediaries who would provide on a commercial basis the coordination functions normally fulfilled by governments. The right holders would use the bands themselves and/or resell or lease licenses to end users. NERA's original proposals were heavily weighted in favor of management rights. It proposed tendering nationwide bands in 16 different parts of the spectrum, including UHF TV and part of the FM frequencies.

NERA recognized, however, that a lot of the demand for radio communication is exclusively local, especially in broadcasting. Theoretically, this would pose no problem as long as the spectrum intermediaries fulfilled the demand for localized uses. However, the number of entities willing and able to take on this kind of responsibility appeared to them to be limited, particularly in a small country like New Zealand. For this reason, the NERA report proposed a dual system of band licenses and localized property rights.

Where the latter rights were used, the government's Radio Frequency Service would retain a residual management role, defining and coordinating localized licenses and policing interference. NERA proposed using localized rights only in AM broadcasting, about half of the FM radio broadcast spectrum, VHF TV, and part of the 470.5 - 494 MHz band. Generally, these were also bands which were largely occupied by incumbents.

In most of the actual tenders, however, the Crown retained the management rights and distributed only license rights. All of the UHF, AM and FM broadcast spectrum was tendered as license rights. Only the cellular and the 2.3 - 2.4 MHz bands were sold off as management rights. Altogether, New Zealand tendered approximately 250 license rights in three broadcast bands, representing a sum of 302 MHz. Only 15 management rights in three bands occupying 146 MHz were tendered. Currently, the Ministry of Commerce is being pressured to follow the same pattern in the land mobile bands. Most land mobile licensees are urging it to retain the management rights and tender license rights to individual end users instead.

The retreat to license rights is an important limit on the scope of spectrum privatization. As long as the Crown retains the management rights, most of the spectrum-management load still falls upon the government. It also means that experience with the working of privately held management rights is quite limited so far.

Strong practical and political constraints were behind MoC's retreat to reliance on license rights. Chief among them were the problems associated with incumbency. The decision to grandfather incumbents and to reserve channels for noncommercial broadcasters made it impossible to dispose of broadcast frequencies as management rights. The channelization plan had to incorporate existing licenses, and the rights that were tendered could not threaten the vested rights. Unless the Crown retained the management rights itself, it would be difficult to meet these obligations.

The UHF broadcast spectrum, which was essentially unused at the time of the tender, was an ideal candidate for distribution as management rights. Here again, political considerations prevented this. At the time of the passage of the act, Sky Network Television Ltd. was poised to use the UHF spectrum for the creation of a new subscription TV service in New Zealand. The government looked favorably upon Sky, because it could be a strong new competitor, and its successful entry could showcase the benefits of its new spectrum policies. From Sky's point of view, however, tendering the UHF-TV spectrum as management rights would have produced only uncertainty and delay. Holders of the management rights would have had to work out noninterfering channelization schemes among themselves within the framework of a law that was entirely new and untested. This probably would have led to long and complex negotiations.

From the standpoint of the government as well, jumping feet first into distribution of management rights, the most revolutionary aspect of the law, also seemed troublesome. As the MoC's Manager of Radio Spectrum Policy put it, "We had to learn to walk before we could run."

Institutional Limitations

Another reason for MoC's heavy reliance on license rights was that it was not clear which private entities would be willing and able to take on management-right responsibilities. Only two institutions possess the economic resources and technical expertise required to manage the spectrum on a commercial basis: Telecom Corporation of New Zealand (Telecom) and Broadcast Communications Ltd (BCL). Telecom is the recently privatized telephone company. Until recently it was part of the Post Office and was responsible for managing a significant part of the country's spectrum. BCL is a subsidiary of TVNZ, the state-owned television broadcaster. As the transmission/radio engineering unit of the former state broadcasting monopoly BCNZ, BCL inherited the best hilltop transmission sites in the country. BCL currently supplies transmission services for TVNZ and other broadcasters.¹⁵

Under the current institutional structure, neither of these two organizations can take on broad spectrum-management responsibilities without raising significant competition policy concerns. There is a potential conflict of interest between their roles as service provider and spectrum supplier to other service providers.

Telecom already is dominant in voice, data, and mobile telecommunications. Its control of the spectrum could be exploited to prevent new competitors or new technologies from undermining its dominance. In the land mobile spectrum, for example, there are many small, independent users currently sublicensed to use Telecom frequencies. Many of these users fear that privatization of the management rights for these bands will give Telecom too much power over their operations and increase its domination of the mobile radio business.

Acquisition of broadcast-management rights by BCL raises the same competitive concerns. BCL is a wholly owned subsidiary of the nation's dominant broadcasting organization. If it obtained management rights to large chunks of the broadcast spectrum, new entrants might be dependent on their prime competitor for access to the spectrum. Furthermore, BCL appears to be unwilling to take on management rights. In part, this is because BCL is a bastion of radio engineering conservatism. Its managers and technical people are critics of the new regime and seem hostile to the whole idea of spectrum-property rights. BCL's representatives perceive a conflict between their mainline business--providing transmission services to broadcasters--and the responsibilities of spectrum management. We are not convinced of the validity of this argument, but in their view spectrum managers must make hard decisions about who can and cannot have broadcast channels, decisions which might poison

their relations with customers of their transmission services. Finally, BCL officials assert that the opportunity to exercise management rights doesn't appear to be a commercially attractive one.

License Rights and Spectrum Markets

License rights do not provide an ideal basis for the operation of a spectrum market. License rights are local rather than nationwide; hence, they must place limits on out-of-area as well as out-of-band radiation. With localized spectrum rights, concrete coordination measures increase in importance relative to simple emission levels in controlling interference. That is, the presence or absence of interference depends on the specific location and engineering configuration of all the other users of the same and adjacent frequencies. The technical interdependence of the property rights makes it difficult to alter them via decentralized market transactions. These problems are compounded by the fact that most holders of license rights are bound to be end-users rather than specialized frequency coordination firms.

A key consideration is whether license rights can be reconstituted by market transactions. That is, can license-right owners subdivide, aggregate, enlarge, reduce, or adjust property rights in response to supply and demand? Overall, the answer seems to be no.

The first round of broadcast tenders led to many demands for the reconstitution of license rights. Many broadcasters won tenders for licenses on the outskirts of cities when their real intention was to broadcast to the urban market. They then sought to modify their licenses to improve their coverage. This process provides a good test of the "restitutability" of license rights in the broadcast spectrum.

We discovered that transactions between license rightholders did not reconstitute spectrum usage in response to supply and demand. License right holders who wanted to change the parameters of their spectrum right contracted with the management right holder, not with other license right owners.

Here is one example. Prior to the FM radio tender, Greater Wellington FM Ltd. ran a successful commercial radio station in Wellington on a temporary license. Greater Wellington failed to win any of the tenders for the Wellington channels; however, it did win a license to the north of Wellington. Like many other broadcasters, Greater Wellington wanted to alter the terms of its suburban license to give its signal greater exposure in the core urban market. How did it go about this? Not by individually contracting with the 10-15 other holders of FM license rights in Wellington.¹⁶ Instead, Greater Wellington negotiated a deal with the Ministry of Commerce, the management right holder. It will sell its license back to the Crown, and the Crown will use the extra space created by vacating the suburban license to create an additional FM license in Wellington (presumably one that will not interfere with

existing license rights). The Ministry will then hold a tender for the new license right. Greater Wellington will be given a preference in the form of a right to match the highest bid. In other words, band usage is responding to market demand by vertical contracts between license and management right holders, not by means of horizontal contracting between license rights holders.¹⁷

The complexity of altering license rights is only one reason why such rights cannot facilitate market transactions. Another reason is the legal status of license rights vis-a-vis management rights. License rights are subordinate to management rights, and their subordinate status limits their ability to function as transferable property rights. Any transactions between license-right holders must be approved by the management right holder. An attempt by community broadcaster Canterbury Television (CTV) to transact with BCL provides an example. CTV won the tender to broadcast on UHF Channel 44 at 500 watts. BCL won the nationwide UHF lot containing UHF Channel 48. CTV wanted to reach more of the Christchurch area with a stronger signal. It therefore contracted with BCL to use channel 48 in Christchurch at 2,000 watts.

One would think that BCL, as the owner of a license right to use Channel 48 in all parts of New Zealand, has the authority to arrange any subcontract with CTV it pleases as long as it does not interfere with other license right holders. However, this is not the case. The BCL-CTV deal has to be approved by the Ministry of Commerce, because the Crown is still the holder of the management right to the UHF spectrum. The CTV power boost would use up more of the spectrum than the original BCL license right, thus denying the Crown the right to use or issue licenses in the remaining parts of the UHF channel 48 spectrum.

Thus, the ability of license-right holders to freely reconstitute their rights is limited by three factors. One is the complexity and expense of altering technically inter-dependent rights via decentralized transactions. Second, such rights will generally be held by endusers who lack the incentives and technical resources required to engage in extensive coordination transactions. Third, any significant reconstitution of license rights is bound to affect the management right. Even if the changes do not interfere with existing licensees, they can affect the value of the management right by extending electromagnetic energy into previously unoccupied parts of the band. Ultimately, reconstitution will depend on the management-right owner.

Experience with Management Rights: AMPS-B

Thus far, experience with privately owned management rights has been minimal. All of the broadcast bands were sold as license rights. AMPS-A has been tied up by litigation over the Commerce Commission ruling. The MDS band has not yet been put into use. Some evidence about the feasibility of private management rights can be obtained, however, from the AMPS-B band.

As the incumbent cellular operator on the AMPS-B spectrum, Telecom Cellular won the management right to that band upon payment of the fee specified in Section 159 of the Act.¹⁸ The company studied the technical implications of the law and prepared a report on how it believes management rights in AMPS-B should be implemented.¹⁹ The report examines the problems Telecom Cellular encountered when attempting to implement management rights.

The Radiocommunications Act gives Telecom Cellular a set of frequencies, an adjacent frequency emission limit (AFEL), and a protection limit (PL). While these specifications were useful starting points, they were not sufficient to protect the cellular bands from interference. In its internal report, Telecom Cellular noted that the specification of AFELs and protection limits is ambiguous. AFELs and PLs are specified by an EIRP (Equivalent Isotropically Radiated Power) at each frequency. The power at a single frequency, however, is always zero; it can only be greater than zero when specified over a range of frequencies. The permissible power levels vary considerably depending on how one specifies this range.

Telecom Cellular dealt with this problem by positing its own bandwidth range for determining AFELs and PLs. These specifications were based on--and could only be based on--knowledge of AMPS equipment standards. Thus, it was the type of communications channel, rather than power limits per se, which determined the limit. This did not solve the problem completely, however. Telecom Cellular's engineering calculations showed that in certain cases (e.g., whenever AMPS-B mobile units come within 8.5 meters of a non AMPS-B transmitter) harmful interference would occur even if the specified AFELs and PLs are met. This problem will have to be controlled by coordinating transmitter sites and frequency usage with adjacent owners.

From Telecom's point of view, the property rights are inadequate because they do not impose any coordination requirement on its neighbors. Also, it notes that when guardbands are necessary to prevent interference, the law does not specify who is responsible for sacrificing bandwidth to achieve protection.

This episode illustrates the strengths and weaknesses of New Zealand's management rights. In practice, property boundaries are not determined by power limits but by service-specific interference criteria. Power limits are a necessary and important part of the boundary-drawing process, in that (despite some ambiguity) they give the management-right holder a legal reference point for calculating how to make AMPS cellular systems compatible with users in adjacent bands. But they still must be supplemented by coordination of adjacent systems to avoid interference. These technical problems are not insurmountable. They could easily be resolved through negotiation, or by making minor amendments to the law.

The Nature of Spectrum Rights

Many of the problems confronted by New Zealand in defining rights can be traced to an assumption that seems to permeate most of the thinking about property rights in radio. This is the fallacy of reifying the spectrum--assuming that it is a thing which can be divided up into discrete parcels. In reality, "the spectrum" is not a thing but a relationship between things. While this argument may sound metaphysical, New Zealand's experience demonstrates in very practical terms why reification of the spectrum will lead policy makers astray.²⁰

A landmark study by a team of economists, lawyers, and engineers in 1969 was the first attempt to define property rights in radio in a way that satisfied rigorous engineering, economic, and legal criteria.²¹ This study, and most which have followed, attempted to find a way to divide the spectrum up into geographic parcels. Spectrum property rights are conceived as the right to fill up a certain volume of space with electromagnetic energy of a certain strength. Interference is controlled indirectly, by limiting out-of-band and out-of-area radiation.

The problem with this approach is that the real resource of value in radio communication is not electromagnetic energy itself, but a workable communications pathway between a transmitter and a receiver (or receivers). The communications channel and its susceptibility to interference depends not only on transmitter power levels, but also on the type of technology used, the characteristics of the receiver, and environmental factors. Spectrum management is more like roadway traffic engineering than natural-resource management. It is a coordination process wherein equipment design and performance, usage, and placement are configured to ensure that electromagnetic energy doesn't collide in ways that wreck communication. Interference protection which focuses exclusively on power levels is bound to lead to overly rigid and inefficient radio communication.

As an alternative to the spatial analogy on which most rights models are based, property rights in radio can be conceived as analogous to rights-of-way. A right-of-way or easement coordinates potentially conflicting activities or uses by carefully specifying the physical relationships between things. For example, a utility pole line may be given the right to run wires across someone's yard at a certain height and a certain distance from a house. The issue here is not how much of some abstract "natural resource" is "consumed" by this use. The question is whether the pole line conflicts with other possible uses, how it can be arranged to avoid such conflicts, and how much the various arrangements cost. (A very high pole, for example, would be more expensive but might prevent the pole line from interfering with backyard baseball games.)

This "metaphysical" digression was intended to lead to a very practical distinction. Power limits are only one of the physical factors that need to be taken into

consideration in radio communication. When power limits are the most important factor in establishing a boundary between users--as they are, for example, in band licenses or management rights--then the type of property rights established in New Zealand will work effectively. When more concrete coordination measures are necessary--as is typically the case in most license rights--then property rights based on spatial models will not facilitate flexibility and market exchanges.

In conclusion, the biggest "problem" with spectrum privatization is that it has not been given much of a chance to work. Political and practical constraints have caused the Ministry of Commerce to back away from the deep reform outlined in the NERA report. In the few cases where private management rights have been distributed, some technical problems have surfaced but they appear to be minor at this stage. New Zealand's government can still overcome the obstacles to deep reform. The Ministry of Commerce could opt to tender off its management rights. Its ability to do this is restricted, however, by institutional factors. During the privatization of Telecom New Zealand and Broadcasting Corporation of New Zealand the government failed to create any organizations that could serve as independent, commercial spectrum-management firm(s). Thus, most of the country's private-sector radio expertise is tied up in organizations such as Telecom New Zealand and TVNZ, entities which cannot take on major spectrum-management functions without raising competition policy concerns.

V. Summary: Toward Spectrum Reform

At both the national and international levels, the electromagnetic spectrum is becoming a communications resource of increasing value and intensifying demand. Although it is a small country, New Zealand's bold experiment is of global significance, because it pioneered the use of market principles in allocating and assigning radio frequencies.

Spectrum Tenders

New Zealand's experiment with tenders can be rated a success. Auctions have proven to be a highly efficient method of resolving competing applications for radio licenses. In only a year and a half, the Communications Division of New Zealand's Ministry of Commerce was able to define and distribute an unprecedented amount of radio licenses to private users. The Ministry received a total of 2,915 bids for 264 contested licenses in 5 different bands, an average of 11 bids per license. Altogether, it released 448 MHz of spectrum in only a year and a half. Without auctions, it would have been impossible to accomplish so much. The Ministry's Communications Division, which administered the auctions, has a total staff of only 144 people, including field staff, and an annual budget of NZ\$ 15.5 million--less than a tenth the size of the FCC's. The auctions brought in a total of at least NZ\$ 36 million; that and the annual fees assessed on licensees will be more than enough to pay for the Division's operations.

(More revenue could have been generated had the agency set a reserve price and/or released spectrum to the public more slowly.)

The New Zealand spectrum auctions demonstrated that auctions can be politically popular as well as efficient. Auctions are now accepted and even welcomed by radio users as a fair and expeditious way of distributing licenses. We spoke to no one in New Zealand who wants to return to tribunals.

Spectrum Privatization

New Zealand's attempt to privatize the spectrum demonstrates that it is technically possible to define workable property rights, but important structural issues must be addressed during the privatization process. Band licenses (management rights) appear to work better than localized license rights as the basis for market regimes. The larger rights minimize the amount of boundary-drawing that must be done and give owners maximum flexibility to adjust uses and users. To use a deliberately provocative analogy, however, band licenses also pave the way for the emergence of radio "landlords" with the power to issue and terminate leases, evict nonpaying "tenants," tear down whole "buildings" and construct new ones.

If a spectrum market can only come through the intermediary of holders of management rights, then the policy problem is no longer "how to define property parcels in the ether." It is more like "how can the *spectrum-management function* be privatized and commercialized?"²² The key policy issues are institutional rather than technical. In retrospect, New Zealand would have made deep reform easier had it created one or more independent, private frequency-management organizations when privatizing its broadcasting corporation and its telephone company.

In the pursuit of deep reform, the important questions are:

- From what existing institutions can privatized, commercialized spectrum management operations be built?
- How should these entities be structured so that they have the proper incentives?
- Should they be separated from or integrated with service providers?
- Should they be separated from or integrated with equipment manufacturers?
- How can the requirement for large bands be reconciled with the need for competition and diversity?

- How can we ensure that privatized-spectrum managers compete effectively when radio frequencies are not homogeneous and are imperfectly fungible?
- How can private management rights be created in bands where there are large numbers of incumbents?

Relevance to the United States

New Zealand's economy, telecommunications industry, geography, and size differ markedly from the U.S. Nevertheless, its experience is directly relevant to many of the current debates surrounding spectrum policy.

With respect to spectrum auctions, the differences between New Zealand and the U.S. would tend to make bidding for licenses work better in the U.S. than in New Zealand. There would be a far larger number of bidders in the market; hence the auction results would more closely approximate perfectly competitive conditions. The likelihood that the pricing anomalies experienced in New Zealand would occur in the U.S. is virtually nil. It would also be impossible for such large quantities of spectrum to be auctioned off within such a short period of time.

The larger scale of the U.S. market means that radio licenses would command higher prices (except, of course, in remote areas). This does not, however, necessarily mean that smaller entrepreneurs would be shut out. In New Zealand, most of the expertise and financial resources are concentrated in only three organizations (Telecom Corporation of New Zealand, TVNZ, and Sky Network Television). Despite this high degree of concentration, the net effect of spectrum tenders was to increase the access of smaller organizations to the airwaves relative to the previous administrative system. Although the larger organizations had no trouble winning the competitions for frequencies that were very valuable to them, the telecommunications marketplace in New Zealand today is far more diverse than it was two years ago. Competitive bidding proved to be a far less formidable obstacle to spectrum access than the delays and uncertainties of the administration process.

No single organization in the U.S. enjoys the financial dominance of Telecom corporation of New Zealand. And given the higher prices that the U.S. spectrum would command, no single organization, no matter how large, could afford to gobble up spectrum it didn't need simply to preempt others (unless, of course, they did it through government lobbying, as often happens today.)

With respect to privatizing spectrum, the situation in the U.S. is far more complicated than in New Zealand. Although the long-term results of the New Zealand experiment may prove to be worthy of emulation, spectrum privatization could not proceed along the same path in this country because there are few unoccupied bands to sell off to private owners. The problem of incumbent licensees, which severely limited the scope

of the New Zealand reforms, is of incalculably greater magnitude in the U.S., where spectrum users are not only more numerous and more diverse, but also better organized politically.

The importance of incumbent users in the U.S. means that the goal of privatization would have to be pursued in different ways. One possibility is that the FCC could continue to expand the technical and economic flexibility of existing licensees, gradually transforming the license into a private-property right. This route, however, makes license rights the basis of spectrum markets, and as noted above (pp. 42-45) license rights do not provide an adequate basis for market allocation of spectrum. Another possibility is that the Congress might try to privatize the FCC instead of privatizing the spectrum per se. That is, the Commission's spectrum management functions could be turned over to private, commercial, independent, and competing "frequency planning organizations" with management rights over large tracts of spectrum. During the transition, incumbent license holders could be grandfathered for the duration of their FCC licenses. When their licenses expired, they would have to bid for them. This proposal, obviously, would require radical legal changes.

Perhaps the most important result of the New Zealand reforms is the demystification of the spectrum market concept. A private-property -based market for radio frequencies can no longer be dismissed as an untested theory. It is an idea well on its way toward realization.

About the Author

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1. U.S. Department of Commerce, National Telecommunications and Information Administration, *U.S. Spectrum Management Policy: Agenda for the Future*. NTIA Special Publication 91-23 (February 1991).
2. The most recent case in point is the 220-MHz proceeding, in which the Commission was deluged with over 100,000 applications for licenses in three days and was forced to suspend the application process.
3. Since the early 1980s the FCC has implemented or proposed such incremental reforms as legalizing use of subcarrier frequencies in the FM broadcast bands for nonbroadcast purposes, a "flexible" allocation in the mobile radio services, greater technical flexibility for licensees, a "pioneer's preference" giving innovators preferred access to new spectrum assignments.
4. The comments of Congressman John Dingell (D-Mich.) are typical of the obstructionist approach taken by opponents of auction authority for the FCC. Dingell stated that the passage of a spectrum reallocation bill "should not be held hostage to theories about spectrum auctions or other problems that involve the Commission's licensing practices. Those problems need to be addressed, but first we must make sure that the Commission has something to license." Dingell makes no suggestions as to how the Commission's licensing problems should be addressed. See *Telecommunications Reports*, July 15, 1991.
5. Other valuable reports on the new system of spectrum management in New Zealand include: Hutchings (1990), Jackson and Foster (1989), and Milner *et al.* (1991). In the first two of these reports, however, the author was directly involved in writing and/or implementing the law. The paper by Milner *et al.* was sponsored by Telecom Corporation of New Zealand.
6. Simon Walker, ed., *Rogernomics: Reshaping New Zealand's Economy* (Wellington: New Zealand Centre for Independent Studies), 1989. Brian Easton, ed., *The Making of Rogernomics* (Auckland: Auckland University Press), 1989.
7. Some examples: New Zealand Steel, sold Oct. 1987 for NZ\$ 327 million; Petrocorp, sold March 1988 for NZ\$ 801 million; PostBank, privatized October 1989 for NZ\$ 678 million; Air New Zealand, privatized October 1989 for NZ\$ 660 million.
8. Dr. John Fountain, *The Economics of Radio Spectrum Management: A Survey of the Literature*. (Wellington: Department of Trade and Industry), June 1988.

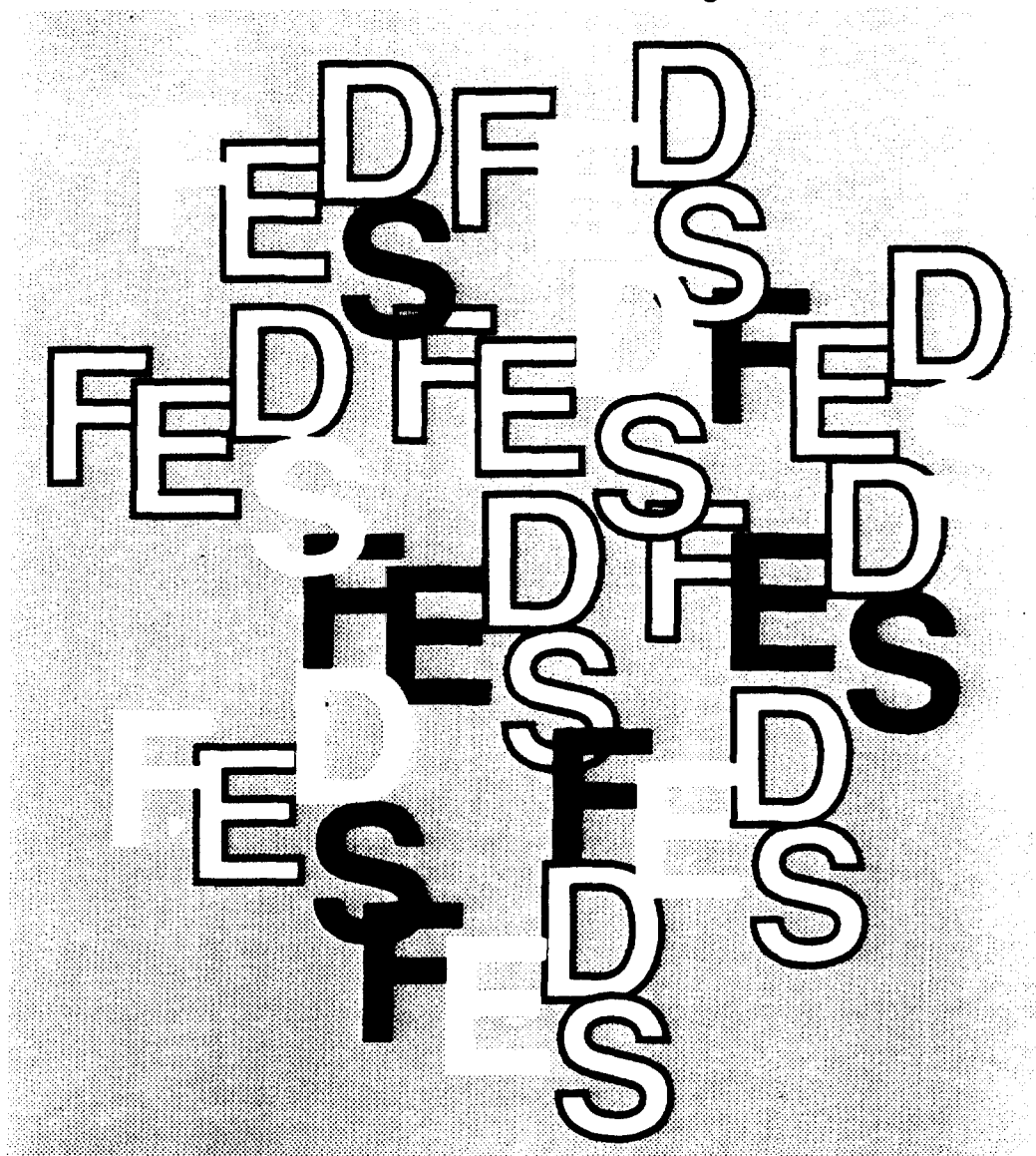
9. National Economic Research Associates, *Management of the Radio Frequency Spectrum in New Zealand* (Wellington, NZ: Ministry of Commerce), November 1988. The NERA Project Team included Robin Foster, Phillipa Marks, William Shew, Charles Jackson, and Robyn Durie.
10. Jackson and Foster (1989), note that "When this section was explained to the NERA team, some thought it was a reasonable precaution, while others felt it was a legal and economic monstrosity." (p. 24)
11. The Maori tribe inhabited the New Zealand islands prior to the Europeans. They now represent about 12% of the population and are concerned about maintaining their traditional culture.
12. The three bands are known as AMPS-A, TACS-A, and TACS-B, and refer to different types of cellular telephone equipment. AMPS, an acronym for "Advanced Mobile Phone Service," is an analogue system that uses 30-kHz channels in the 824-MHz to 894-MHz band. AMPS is an established standard in the U.S., Canada, Australia, most of Latin America, Hong Kong, Singapore, and Taiwan. TACS is a newer cellular system that uses 25-kHz channels and frequencies in the 890 - 960 MHz range. TACS is a recognized standard in the U.K., China, Hong Kong, and parts of the Middle East.
13. The exception is the cellular proceeding, in which the Commerce Commission disallowed the results of the tender on competition policy grounds. In this case the delay was not caused by the tendering process itself, but by the imposition of other considerations (competition policy). For a discussion, see section II.5b.
14. New Zealand Commerce Commission, "Determination under the Commerce Act 1986 in the matter of a merger or takeover proposal involving: Telecom Corporation of New Zealand Ltd. (Purchaser), the Crown (Vendor)." Decision Number 254, October 17, 1990.
15. BCL's ability to take on a management role is underscored by its recent attempts to convince the MoC to retain it as a consultant when drawing up channelization plans for future tenders.
16. Aside from the expense of such negotiations, there is little incentive for any of the existing broadcasters to make room for a competitor. The only practical way for Greater Wellington to enter the market via contracting with other license-right holders is to buy one of the existing channels outright, rather than to reconstitute the right.

17. For a complete description of the government's policy for amending broadcast licenses, see the document by the Ministry of Commerce, "New Licenses and Variations to Licenses for Radio Broadcasting," March 13, 1991.
18. Telecom Cellular will pay a lump sum equal to the product of (1.5% of its annual revenues in 1991) x 4.87. This is expected to be around NZ\$ 6 million, or about half of the price Telecom would have paid in the open tender for AMPS-A.
19. Peter Gardenier, "Spectrum Management Rights for the AMPS-B Bands," Telecom Corporation of New Zealand Ltd. Technology Strategy Group, Corporate Strategy Division, Telecom Corporate Office, March 1991.
20. For elaboration of some of these points, see Milton Mueller, "Technical Standards, the Market, and Radio Frequency Allocation," *Telecommunications Policy*, March 1988.
21. Arthur S. DeVany, Ross D. Eckert, Charles T. Meyers, Donald J. O'Hara, Richard C. Scott. "A Property System for Market Allocation of the Electromagnetic Spectrum: A Legal-Economic-Engineering Study," *Stanford Law Review*, Vol. 21, June 1969, pp. 1499-1561.
22. A consultancy report published in the U.K. proposed a similar idea in 1988. The report proposed creating private, commercial "Frequency Planning Organizations" (FPOs) to replace government allocation. CSP International, *Deregulation of the Radio Spectrum in the U.K.*, Department of Trade and Industry, (London: HMSO) 1987.

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THEORY AND EVIDENCE ON REFORM
OF THE TREASURY'S AUCTION PROCEDURES

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March 1992

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Theory and Evidence on Reform of the Treasury's Auction Procedure

March 1992

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* Chief, Banking and Money Market Analysis Section; Mail Stop 72; Washington, DC 20551. Some of the material in this paper is contained in the *Joint Report on the Government Securities Market* (Washington, DC: GPO), 1992. I have benefitted from comments by many people. A partial listing, in which inclusion in no way implies agreement, includes: Norman Carleton, Debbie Danker, Sally Davies, Sherry Edwards, Jon Faust, Mark Fisher, Milton Friedman, Steven Fries, Christian Gilles, Dave Gordon, Dale Henderson, Rob Kahn, Leora Klapper, Don Kohn, Myron Kwast, Mike Leahy, Dave Lindsey, Steve Lumpkin, Pat McAllister, Athanasios Orphanides, Jill Ouseley, Dianne Pauls, Matt Pritsker, Carmen Reinhart, Rich Rosen, and Dave Simon. Of course, the views expressed are my own and do not necessarily reflect those of the Board of Governors of the Federal Reserve System or any other members of its staff.

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ABSTRACT

This paper critically reviews the U.S. Treasury's current procedure for selling securities and an alternative technique suggested by Milton Friedman. The current practice of soliciting sealed bids and awarding securities at the highest prices probably restrains demand at auctions and provides opportunities for market manipulation. Milton Friedman's proposal, that the Treasury end its price discrimination by charging a single price to all winning bidders, would entice investors to enter auctions directly, benefitting Treasury revenue. However, this paper suggests an alternative scheme--conducting auctions via a real-time, automated network with repeated bidding--that should more effectively combat manipulation and, perhaps, further improve auction participation.

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I. Introduction

Last year's admission by Salomon Brothers of recurring infractions at Treasury auctions has brought forth calls for reform of auction procedure. By reviewing the academic literature on auctions, this paper puts current practice in critical perspective, evaluates Milton Friedman's reform proposal, and offers an alternative scheme that uses technology to better protect against collusive behavior while perhaps promising revenue gains.¹

The specifics of the Treasury market make it difficult to apply standard auction theory to assess Treasury practice. Unlike simple theoretical constructs, the Treasury offers multiple units of the auctioned security, with open trading in securities preceding (in the when-issued market) and following (in the secondary market) the auction. Also, a potential customer can adjust behavior at many margins by varying the amount of information he or she collects before the auction, altering the volume of bids, or placing bids indirectly through dealer intermediaries. These variations from received theory could have important consequences for the efficacy of any reform.

However, theory does point in a clear direction on this issue, suggesting--albeit through simpler models than market reality--that the current Treasury practice of soliciting sealed bids and awarding securities at the highest prices can be improved upon for two reasons. First, since securities are awarded at bid prices at and above the lowest winning bid, a too-aggressive bidder may pay well above the average award. Thus, there is an incentive to position bids

1. This paper examines Treasury reform at a relatively high level of generality. A companion paper, "Specifics on Reform of the Treasury's Auction Procedure," which is scheduled to be presented at a summer conference on auctions, considers the practical problems.

as close as possible to the market consensus. Strategic investors shade their bids below their reservation prices, restricting overall demand for the auctioned securities. Entering an auction, knowledge about the distribution of bids is at a premium, so investors willingly turn to experts--the dealers--rather than place bids directly. This concentration of customer orders can provide cover for any collusive arrangement. Second, the Treasury solicits sealed bids, so that a group of would-be manipulators only need to bid slightly above the consensus to garner the bulk of the issue. Because of the auction's closed nature, the manipulators' surprising demands for the security are revealed to other market participants after the bidding is over with the announcement of awards.

Friedman proposes that the Treasury end its price discrimination by charging a single price to all winning bidders, with the hope that this would narrow the extent of bid shading and entice investors to enter auctions directly.² This single change, Friedman argues, would eliminate all differences between the auction and secondary markets. As a result, there would be no possibility of cornering an issue, because the schemer who bid securities away from investors at an auction will not find them willing to pay a higher price in the secondary market. However, if market reality is not Friedman's frictionless world, then any differences in the primary and secondary markets that remained after the change in auction format could be exploited by a market manipulator.

By keeping bidding sealed, Friedman's proposal, in fact, encourages such stratagems should differences remain between the primary and secondary markets. A cornering coalition could place bids

2. Milton Friedman, "How to Sell Government Securities," *Wall Street Journal*, August 28, 1991.

for a substantial fraction of an issue well above the market consensus, ensuring awards, but pay only that price required to allocate the remaining portion of securities to their unsuspecting competitors. Instead, an auction conducted in the open, via a real-time computer connection with repeated bidding, would force the pool to make its intentions public while bidding was active, allowing their competitors to adjust their strategies. Hence, the pool may fail to corner the security or, at the least, would find it a more expensive proposition. As a result, the Treasury would benefit to the extent that the price of the issue was bid up in the attempt.

The rest of this paper expands on these arguments by providing a brief summary of the four major types of auctions and a closer look at the information provided by auction format. It then examines the potential for illicit profit in auctions, using supply and demand diagrams to explain how one type of market "squeeze" works. A brief discussion of the collusive potential in auctions suggests that the major danger lies in the action of a single dealer, not in the conspiring of a group of dealers, to rig the results. Next, the paper discusses the Friedman proposal in more detail, particularly examining the consequences for cornering and Treasury revenue. A review of empirical work in Section VI proves ambiguous, as there are few experiments directly comparable to the Treasury setup. Section VII lists the practical arguments for the current system that are not addressed in theoretical models. The last two sections present an alternative auction scheme and offer some conclusions. These conclusions, however, only can be regarded as tentative, since the rarified world of academic models of auctions is far removed from the reality of the Treasury market. Further, the design of an experiment implementing these auction reforms will require much more

detail than that provided in this paper--detail that only could be arrived at by closely consulting with market practitioners.

II. Background on Bidding

There is a large academic literature on auctions, with important early contributions by William Vickrey and Milton Friedman, as well as significant later work by Paul Milgrom, among others.³ This research has classified the types of auctions, rigorously modelled the bidding strategies, and established the efficiency properties of the outcomes. Indeed, there are a number of strategic similarities among auctions, as well as equivalence propositions concerning the revenue to the seller. Unfortunately, this literature has a language all its own that is at variance with the terms used by the financial press. To avoid confusion, this paper will use explicit, if somewhat unwieldy, names for each auction.

The taxonomy of auctions owes to William Vickrey, who classified them based on the order in which prices are quoted, as well as the forum. First, awards can be made at prices that are progressively lowered until the security is sold; alternatively, the bids can be arranged in ascending order by their price and a single

3. The early references include William Vickrey, "Counterspeculation, Auctions, and Competitive Sealed Tenders," *Journal of Finance*, vol. 16, March 1961, pp. 8-37, and Milton Friedman, "Comment on 'Collusion in the Auction Market for Treasury Bills,'" *Journal of Political Economy* vol. 72, October 1964, pp. 513-514. Recent work is summarized and reviewed in R. Preston McAfee and John McMillan, "Auctions and Bidding," *Journal of Economic Literature* vol. 25, June 1987, pp. 699-738; Paul Milgrom, "Auctions and Bidders: A Primer," *Journal of Economic Perspectives* vol. 3, Summer 1989, pp. 3-22; and Paul Milgrom and Robert J. Weber, "A Theory of Auctions and Competitive Bidding," *Econometrica* vol. 50, September 1982, pp. 1089-1122; and Vernon Smith's entry "Auctions" in John Eatwell, Murray Milgate, and Peter Newman, editors, *The New Palgrave: A Dictionary of Economics* (New York: Macmillan Press), 1987, pp. 138-144. A less rigorous overview with applications to Treasury securities is provided by Loretta J. Mester, "Going, Going, Gone: Setting Prices with Auctions," Federal Reserve Bank of Philadelphia *Business Review*, March/April 1988, pp. 3-13.

price decided that just exhausts the total issue. Second, by another metric, the auction can be a private affair with sealed bids opened by the auctioneer; on the other hand, the auction could be conducted in real time, with participants in a single room, or connected by phone, bidding in public. This two-by-two classification scheme yields four auction types. Complicating matters, models can be stratified further by the assumption concerning bidders' information on the value of the auctioned object. In the private-values case, bidders' valuations are subjective decisions, independent of each other. In the common-values case, each participant attempts to measure the value of the item by the same objective yardstick. The auction of a unique artwork not for resale is the prototypical private-values model, while a Treasury auction--with each bidder guessing at the security's value at the end of the day--is an example of a common-values model. This paper will concentrate on the common-values case that is applicable to the sale of Treasury securities.⁴

First-price sealed-bid auction. The Treasury's current practice falls into this category, which in the financial community is termed an English auction (excepting by the English, who call it an American auction). Bidding takes place in private and, as seen in Figure 1, awards are made at the highest prices covering the total auction size.⁵ Thus, participants pay differing prices reflecting the strength of their bids, where the surest winner is the one

4. Additionally, we will assume that agents only care about maximizing profit, implying that they are risk neutral.

5. It is termed a first-price auction because in the sale of one unit of good or security the award is made at the highest bid. In the figure, the horizontal bars measure the cumulative amount of bids at the given price or higher. Treasury auctions are actually conducted in terms of yields rather than prices: for intuition's sake, I will work in price terms.

First-price sealed-bid

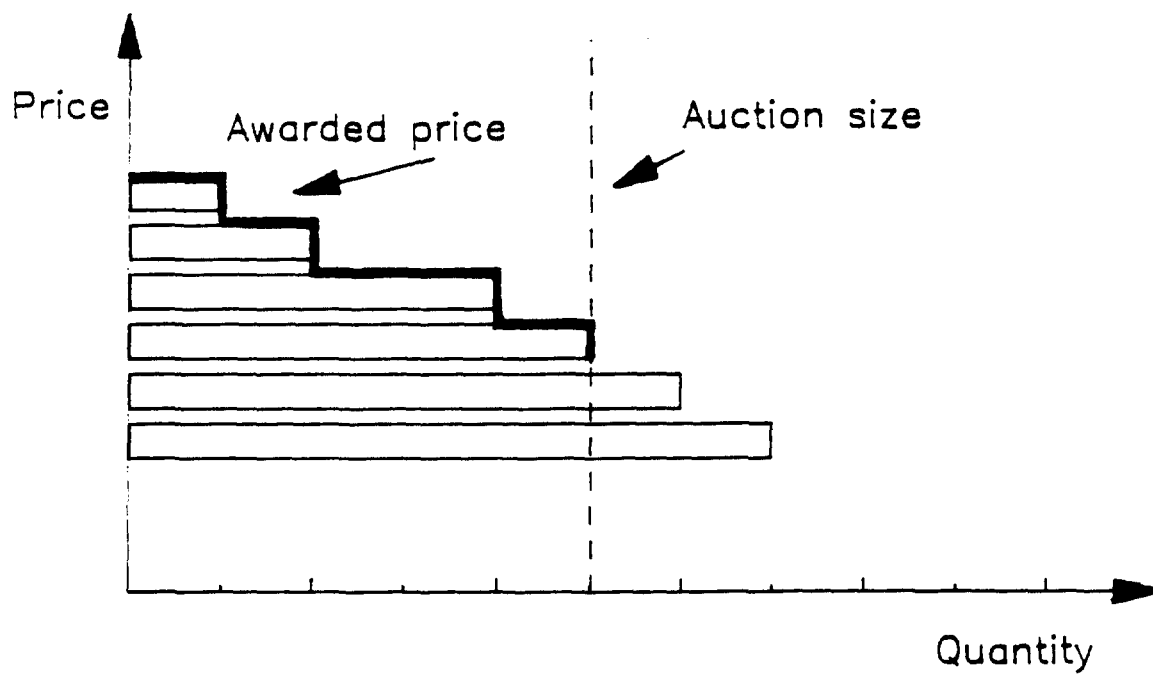


Figure 1

furthest above the market consensus. In that sense, winning is losing, as entering the highest bid signals that your valuation exceeds that of all other interested parties. Since all participants, in effect, guess about the same price--where the security will trade after the auction--a high bid signals a heightened probability of subsequent loss for that bidder. This is the "winner's curse" and causes aggressive bidders to rein in their enthusiasm. The optimal strategy is to shade a bid toward the perceived market consensus, where the more certain that consensus (in terms of lower variability), the more will the strategic investor shade his or her bid.⁶ Additionally, avoiding the winner's curse may lead to the pooling of bids, as a group of investors are more likely to have a clearer view of the market consensus and are less likely to be in the far tail of the bid-price distribution. The pooling of bids is a service provided by dealers, who collect customer business and place large-scale orders.

Second-price sealed-bid auction. This is the broad outline of the Friedman proposal and is called a Dutch auction in the financial press. The Treasury could collect sealed bids, arrange them by price, and (as seen in Figure 2) choose a single price that just places the entire issue.⁷ Aggressive bidders receive sure awards but pay a price closer to the market consensus. As a result, there should be less of the shading that marks the response to the winner's curse. Accordingly, customers might be more willing to place their

6. As explained in James L. Smith, "Non-Aggressive Bidding Behavior and the 'Winner's Curse,'" *Economic Inquiry* vol. 19, July 1981, pp. 380-388.

7. It is called a second-price auction because when a single unit is on the block, the price charged would be that of the highest failed bid, or the second-best price.